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Classification Scheme

The headings shown below are used for indexing papers published in the Journal of the Physical Society of Japan. This classification scheme is a modified version of PACS (Physics and Astronomy Classification Scheme).

General

02. Mathematical methods in physics.
Algebra, geometry, differential geometry, topology, graph theory, and functional analysis. Probability theory, stochastic processes, and statistics. Numerical analysis. Computational techniques.

03. Classical and quantum physics: mechanics and fields.
Classical mechanics; general mathematical aspects. Special relativity. Fundamental theory of quantum mechanics. Theory of quantized fields; mathematical.

04. Relativity and gravitation.
General relativity. Gravitational waves. Unified field theories and other theories of gravitation. Quantum theory of gravitation. Experimental tests of general relativity.

05. Statistical physics and thermodynamics.
Statistical mechanics. Kinetic theory. Ensemble theory. Fermion systems. Boson systems. Fluctuation phenomena and Brownian motion. Lattice theory and statistics. Equilibrium and non-equilibrium thermodynamics. Thermodynamics of phase transitions and critical point phenomena.

06. Measurement science, general laboratory techniques, and instrumentation systems.
Measurement and error theory. Units. Measurement standard. Determination of basic quantities. General instrumentation.

07. Specific instrumentation and techniques of general use in physics.
Instruments and techniques (mechanical, thermal, electrical and magnetic). High pressure production. Vacuum production. Magnetic resonance spectrometers. Optical instrumentation and spectrometers. Mass spectrometers. Particle beam production.

The physics of elementary particles and fields

11. General theory of fields and particles.
Field theory (axiomatic approach, renormalization, gauge field theories), S-matrix theory. Symmetries and conservation laws. Relativistic scattering theory. Other topics in general field theory.

12. Specific theories and interaction models; particle systematics.
Unified field theories and models. Models of weak interactions. Composite models. Hadron classification schemes and hadron mass formulas.

13. Specific reactions and phenomenology.
Weak and electromagnetic interactions of leptons. Leptonic, semileptonic and hadronic decays. Electromagnetic processes and properties of hadron, photon and lepton interactions with hadrons. Hadron-induced reactions and other topics in specific reactions and phenomenology of elementary particles. Cosmic ray interaction.

14. Properties of specific particles and resonances.
Hadron reactions. Lepton, hadron, and resonances. Quarks, gauge particles, magnetic monopoles and other hypothetical particles.

Nuclear physics

21. Nuclear structure.
General and average properties of nuclei. Properties of nuclear levels. Nuclear forces. Few nucleon systems. Hypernuclei. Nuclear matter. Nuclear models and methods.

23. Nuclear decay and radioactivity.
Electromagnetic transition, β-decay, electron and muon capture and α-decay.

24. Nuclear reactions and scattering: general.
Resonance and direct reaction, polarization in reactions, and fission. Models and methods. Statistical theory. Other topics in nuclear reaction and scattering: general.

25. **Nuclear reactions and scattering: specific reactions.**
Nuclear reactions and scattering induced by photon, lepton, nucleon, light ions, heavy ions, meson and hyperon. Fission.

27. **Properties of specific nuclei listed by mass ranges.**

28. **Nuclear engineering and nuclear power studies.**
Neutron physics. Nuclear reactors. Isotope separation and enrichment. Nuclear explosions. Radiation technology.

29. **Experimental methods and instrumentation for elementary-particle and nuclear physics.**
Preacceleration. Linear and cyclic accelerators. Storage facilities. Particle sources and targets. Radiation detectors. Nuclear electronics. Polarization analysis. Nuclear information processing. Other topics in nuclear experimental methods and instrumentation.

Atomic and molecular physics

31. **Electronic structure of atoms and molecules: theory** (see also 71. Electron states in condensed matter)
General theory and specific calculations of electronic structure, transitions, and excited states. Effects of molecular interactions on electronic structure including molecular solids and potential energy surfaces for chemical reactions.

32. **Atomic spectra and interactions of atoms with photons.**
Atomic spectra in any wavelength range. Zeeman and Stark effects. Intensities and shapes of spectral lines. Optical pumping. Ionization. Auger effect. Multiphoton and nonlinear processes.

33. **Molecular spectra and interactions of molecules with photons.**
Observations and calculations of rotational, vibrational, and electronic spectra. Intramolecular interactions. Double and multiple resonances. NMR, NQR, EPR, and Mössbauer effects. Fluorescence. Radiationless transitions. Optical pumping. Ionization. Dissociation. Multiphoton processes. Photoelectron spectra.

34. **Atomic and molecular collision processes and interactions.**
General theories and models. Interatomic and intermolecular potentials and forces. Elastic and inelastic scattering of atoms and molecules. Charge transfer. Electron scattering.

35. **Experimentally derived information on atoms and molecules: instrumentation and techniques.**
Masses. Electric and magnetic moments. Polarizabilities. Fine and hyperfine coupling constants. Ionization potentials. Rotation and vibration constants. Dissociation energies. Barrier heights. Structural parameters. Correlation times in molecular dynamics. Atomic and molecular measurements and techniques.

36. **Studies of special atoms and molecules.**
Exotic atoms and molecules (*e. g.*, mesic atoms and molecules). Macromolecules and polymer molecules. Atomic and molecular clusters.

Classical areas of phenomenology (including applications)

41. **Electricity and magnetism: fields and charged particles.**
Classical electromagnetism, particles in electromagnetic fields. Particle beams. Particle optics and other topics in electricity and magnetism.

42. **Optics.**
Geometrical optics. Physical optics. Coherence optics. Quantum optics. Integrated optics. Masers and lasers. Physiological optics. Atmospheric optics. Optical devices and instruments. Optical standards.

43. **Acoustics.**
Linear and nonlinear acoustics. Ultrasonics. Mechanical vibrations and shock. Noise. Acoustic signal processing. Acoustic holography. Acoustical measurements and instrumentation.

44. **Heat flow, thermal and thermodynamic processes.**

46. **Mechanics, elasticity, and rheology.**

47. Fluid dynamics.

General theory. Inviscid flows. Laminar flows. Stability and waves. Turbulence. Compressible flows; shock and detonation. Rarefied gas dynamics. Magneto- and electrofluid dynamics. Reactive, radiative, or nonequilibrium flows. Geo- and astrophysical applications. Fluid dynamic models and other topics in fluid dynamics.

Fluids, plasmas, and electric discharges

51. Kinetic and transport theory of fluids; physical properties of gases.

Kinetic and transport theory. Viscosity and diffusion. Thermal properties. Acoustic properties. Ultrasonic relaxation. Electrical, magnetic and optical phenomena in gases.

52. The physics of plasmas and electric discharges.

Elementary processes. Plasma kinetic equations. Transport processes. Magnetohydrodynamics. Wave oscillations and instabilities. Plasma interactions with wave and beam. Solid-plasma interaction. Plasma production, heating, diagnostics, equilibrium, and confinement. Relativistic plasma. Plasma simulation. Plasma devices.

Condensed matter: structure, mechanical and thermal properties

61. Structure of liquids and solids; crystallography.

Determination of structures by means of diffraction (X-ray, neutron and electron) and by other methods. Crystalline and liquid states. Liquid crystals. Amorphous and polymeric materials. Defects in crystals. Radiation damages. Channelling.

62. Mechanical and acoustical properties of condensed matter.

Mechanical and acoustical properties of liquids and solids. Mechanical and elastic waves. Anelasticity, internal friction, and mechanical resonances. High-pressure and shock-wave effects in solids. Ultrasonic relaxation.

63. Lattice dynamics and crystal statistics.

Vibrations in crystal lattices and disordered systems. Statistical mechanics of lattice vibrations and of displasive phase-transitions. See also 65 (thermal properties), 66 (thermal conduction), 68 (vibrations at surface or interface) and 78 (infrared and Raman spectra).

64. Equations of state, phase equilibria, and phase transitions.

Theory and experiment on equations of state. General studies of phase transitions and critical phenomena except for quantum fluids (67), superconductors (74) and magnetic materials (75). Statistical mechanics of model systems. Solubility and segregation.

65. Thermal properties of condensed matter.

Heat capacity. Thermodynamic properties and entropy. Thermal expansion and thermomechanical effects.

66. Transport properties of condensed matter (nonelectronic).

Diffusion and ionic conduction in liquids and solids. Thermal conduction in nonmetallic liquids and solids.

67. Quantum fluids and solids: liquid and solid helium.

Quantum effects on the structure and dynamics of nondegenerate fluids. Superfluidity of liquid ^{4}He. Normal Fermi fluids and superfluids of ^{3}He. Solid ^{3}He and related quantum crystals.

68. Surfaces and interfaces; thin films and whiskers (structure and nonelectronic properties).

Fluid surfaces and fluid-fluid interfaces. Liquid thin films. Solid surface structures. Vibrations at solid surfaces and interfaces. Surface energy of solids. Solid-fluid interface processes. Solid-solid interfaces. Epitaxy. Whiskers and dendrites.

Condensed matter: electronic structure, electrical, magnetic, and optical properties

71. Electron states in condensed matter.

Band structure of crystalline metals, semiconductors and insulators. Computational techniques of band calculation. Positron states except for positron annihilation (78). Metal-insulator transition. Many body effects (exchange and correlation effects, excitons, polarons, electron-hole drops). Localized states due to impurities and defects. Crystal fields. See also 63 and 73.

72. Electronic transport in condensed matter.

Electronic conduction in metals, alloys, semiconductors and insulators. Photoconduction, magneto-acoustic effect and solid-state plasma effects. Noise processes and phenomena.

73. Electronic structure and electrical properties of surfaces, interfaces, and thin films.

Electronic surface state, surface conductivity, surface double layers, Shottky barriers, and work functions. Interface and related problems such as tunnelling and heterojunctions. Electronic properties of thin films.

74. Superconductivity.

Theories of superconductivity. General properties of superconductivity. Fluctuations and critical effects. Proximity effects, tunnelling phenomena, and Josephson effects. Superconducting materials.

75. Magnetic properties and materials.

General theory and models of magnetic ordering (*e. g.*, ferro-, ferri-, and antiferromagnetism). Diamagnetism and paramagnetism. Kondo effects. Spin arrangements in magnetically ordered materials (neutron studies, etc.). Magnetically ordered materials. Spin dynamics. Exchange and superexchange. Magnetic phase transitions. Critical phenomena and short range order. Domain effects, magnetic films, and magnetic bubbles. Magnetoelectric effects and other topics.

76. Magnetic resonances and relaxations in condensed matter; Mössbauer effect.

General theory of resonances and relaxations. Electron spin resonances and relaxations. Diamagnetic and cyclotron resonances. Nuclear magnetic resonance and relaxation. Magnetic double resonances. Mössbauer effect; other γ-ray spectroscopy and muon spin rotation.

77. Dielectric properties and materials.

Permittivity. Polarization and depolarization effects. Dielectric dispersion. Dielectric breakdown. Piezoelectricity. Electrostriction. Pyroelectricity. Ferroelectricity. Antiferroelectricity.

78. Optical properties and condensed-matter spectroscopy and other interactions of matter with particles and radiation.

Optical properties and materials (including acousto-optical, electro-optical, magneto-optical and other effects). Infrared and Raman spectra and scattering. Brillouin and Rayleigh scattering. Visible and ultraviolet spectra. Stimulated emission. Luminescence. Spectroscopy in vacuum ultraviolet and X-ray regions. Positron annihilation.

79. Electron and ion emission by liquids and solids; impact phenomena.

Impact phenomena (including electron spectra and sputtering). Thermoionic emission. Photo-emission and photoelectron spectra. Field emission, exoelectron emission and resonance tunnelling.

Cross-disciplinary physics and related areas of science and technology

81. Materials science.

Methods of crystal growth and preparation of materials. Phase diagrams and microstructures. Treatment of materials and its effects. Materials testing.

82. Physical chemistry.

Chemical kinetics and reactions including polymerization. Photochemistry, radiation chemistry, and radiochemistry. Chemical thermodynamics. Surface Processes and disperse systems. Chemical analysis and related physical methods.

84. Electromagnetic technology.

85. Electrical and magnetic devices.

87. Biophysics.

General theoretical biophysics. Molecular biophysics. Membrane biophysics. Cellular biophysics. Biophysics of neurophysiological processes.

89. Other areas of research of general interest to physicists.

Geophysics, astronomy, and astrophysics

91. Geophysics, astronomy, and astrophysics.

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